Nadine: A Human-like sociable and emotional robot that remembers facts and people

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Empowering Human Capacity

– We have evolved and progressed.
– We have invented and discovered.
– We are empowered...
**Empowering Human Capacity**

Leonardo da Vinci (1452-1519) created the **robotic knight** capable of independent motion - sitting down, standing up, moving its head and lifting its visor.

Denis Diderot (1713-1784) formulates in his *Pensées philosophiques*: "If we find a parrot who could answer to everything, I would claim it to be an intelligent being without hesitation"
From Hand Work to Factory System (19th century)
Women at the Factory Today
Robots at the Factory Today
Creating Artificial Intelligence to empower humanity?

Can a machine think? Turing Test (1950)

Put a machine and a human in a room and send in written questions. If we cannot tell which answers are from the machine or the human, the machine is thinking...
What first passed the Turing Test and is it enough?

• The first was ELIZA, a program written by the American Computer scientist, Joseph Weizenbaum (1976)

• BUT anything like human intelligence must be able to engage with the real world, with social interaction, and the Turing Test doesn’t test for that.
What has changed in computers?

- **60 years ago**, computers: mainly CPU + Memory + very limited I/O.

- **Today**: CPU and memory are much faster AND incredible possibilities of interfacing with people through sensors and actuators.
Empowering Human capacity today?

• Hardware/software tools allowing to **capture, understand, produce a lot of signals:** speech, sounds, gestures, shapes, forces etc...

• **Generate Big Data** that allows us to **analyse** and **model** events or **predict** the future using deep learning algorithms
MANUFACTURER: RobotCub ConsortiumItalian / Institute of Technology
YEAR OF CREATION: 2004
LOCATION: Europe
HEIGHT: 3.3ft (1 m)
WEIGHT: 48.5 pounds (22 kg)
DEGREES OF FREEDOM: 53 DOF
### SoA: Humanoid robot ASIMO

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>Honda</th>
</tr>
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<tbody>
<tr>
<td>YEAR OF CREATION</td>
<td>2000</td>
</tr>
<tr>
<td>LOCATION</td>
<td>Japan</td>
</tr>
<tr>
<td>HEIGHT</td>
<td>4 ft 3in (130 cm)</td>
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<tr>
<td>WEIGHT</td>
<td>110 pounds (50 kg)</td>
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<tr>
<td>DEGREES OF FREEDOM</td>
<td>57 DOF</td>
</tr>
<tr>
<td>POWER</td>
<td>Rechargeable 51.8V Lithium Ion Battery</td>
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SoA: Humanoid robot Atlas

<table>
<thead>
<tr>
<th>MANUFACTURER</th>
<th>Boston Dynamics</th>
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<tbody>
<tr>
<td>YEAR OF CREATION</td>
<td>2013</td>
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<tr>
<td>LOCATION</td>
<td>United States</td>
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<tr>
<td>HEIGHT</td>
<td>6 ft (180 cm)</td>
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<tr>
<td>WEIGHT</td>
<td>330 pounds (150 kg)</td>
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<tr>
<td>DEGREES OF FREEDOM</td>
<td>28 DOF</td>
</tr>
<tr>
<td>POWER</td>
<td>Electric power supply via a flexible tether</td>
</tr>
</tbody>
</table>
• In most countries, aged people with special needs often feel lonely and are alone
• The situation is worsened over time…
In 2050, Japan will have 72 dependent people over 65+ for every 100 workers; Germany will have 60 dependent people over 65+, etc...

Source: UN Population Division.

www.weforum.org
Paro robot baby seal

- Designed by Takanori Shibata and produced in 2002
- Responds to petting through tactile sensors by moving its tail
- Responds to sounds and can learn a name
- Can show emotions such as surprise, happiness and anger.
Early models of nursing-care assistant robots

-- Physically support

**RIBA robot** (Robot for Interactive Body Assistance)

Robot that can lift up or set down a real human from or to a bed or wheelchair.

Social playing robots

-- Entertainment

→ Play with children.
→ Interact with humans.

Sony AIBO robot: quadruped dog-like robots

Human-robot interaction therapy

- Psychic support
- Reduces stress
- Stimulates interaction
- Improves the relaxation and motivation.

Autism Spectrum Disorder

NAO robot: a semi-autonomous, programmable humanoid robot

Care-o-bot robot equipped with the latest state-of-art industrial components. Experience in a senior home in Germany

- range and image sensors for object learning and detection in real-time 3D environment

Challenges in autonomous behavior generation

• Virtual characters and robots interacting with people in social contexts
  – should understand the other users’ behaviors,
  – and respond back with gestures, facial expressions and gaze.

• Challenges:
  – Sensing and interpreting other users’ behaviors, intentions
  – Making decisions appropriate to the social situation based on partial sensory input
  – Rendering synchronized and timely multi-modal behaviors
• Episodic memory is the memory of autobiographical events (times, places, associated emotions, and other contextual who, what, when, where, why knowledge) that can be explicitly stated
  • keeping the course of dialogue
  • planning long-term goals
  • explaining reasons for actions
  • learning from past experiences
  • requires a personal history of an entity

Episodic Memory

Social sciences as a starting point

- Conceptual definitions (Tulving [Tul72], Schank [SA77])
  - inspiring but lack of details for implementation of robots/VH

- Findings from social sciences
  - Three phases of EM
  - Forgetting and recency effect
    - emotional memories are remembered more

• Overall Goal: long-term social interaction framework with a human-like robot or Virtual Human: modeling emotions, episodic memory and expressive behaviour

• Goal: remembering individuals (faces and names) and past exchanges over multiple interactions

Eva teaching introductory computer networks concepts
MIRALab robotic tutor (2008-2012)
**Recent social robot: Nadine**

<table>
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<tr>
<th>SPECIFICATIONS</th>
<th>Details</th>
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<td>MANUFACTURER</td>
<td>IMI, NTU / Kokoro Company Ltd.</td>
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<td>YEAR OF CREATION</td>
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<td>WEIGHT</td>
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<td>DEGREES OF FREEDOM</td>
<td>27 DOF</td>
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<tr>
<td>POWER</td>
<td>500W</td>
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Hardware

- To valve unit
- Air outlet
- Power switch
- Fireman switch board
- Air dryer
- Air tank
- Air compressor
- Supply air valve
- Valve unit
- Digital computer
- Nadine robot
Augmented/Artificial intelligence (AI):
1. Each partner should be aware of the situations of all other partners and the environment and be able to collaborate and interact in an intelligent way (mixed society).
2. Social robots should be able to switch smoothly between autonomy and control mode.
3. Develop Egocentric vision for mobile platform for Vhumans and social robots (vision centred on robot moving).
Perception/Decision/Action

- Microsoft Kinect V2:
  - Face recognition
  - Gestures recognition
  - Understanding of social situations
- Microphone:
  - Speech recognition
- Emotion Model
- Memory Model
- Social Attention
- Chatbot
- Robot controller:
  - Emotional expression
  - Lips synchronization
  - Online gaze generation
Mixing real people with autonomous virtual humans and social robots: ongoing research

http://imi.ntu.edu.sg/BeingThereCentre/Pages/BTChome.aspx
Decision making

• To whom should the VH/robot engage to talk?
• Should it allow the person to interrupt?
• Should it take the turn?
• Should it give the turn?
• Should it contribute to the speaking group?
• Should it interrupt someone else?
• Should it address a specific person or address the whole group?
NADINE SOCIAL ROBOT
PRESS RELEASES
Real-time interaction with Nadine in video telepresence

[1] Demo was showed at Swissnex Singapore End of Year Party 2013
Social Robots and Privacy

• Social robots capture data from people (faces, dialogues, places, habits...) like humans.
• Humans can do this only for a few people. Robots do it for all people.
• Robots can then report on any situation for anybody and can potentially remember forever.